PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to a method of Heat Treating Silicon Steel

We, BLAW-KNOX COMPANY, a corporation organised under the laws of the State of Delaware, United States of America, of 100 West Tenth Street, Wilmington, State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to heat treating silicon steel. It has to do specifically with the heat treatment of silicon steel at high temperature. The invention provides an improvement in the heat treating of silicon steel at high temperature which obviates disadvantages of prior methods.

Silicon steel in sheet form (sheets or strip) is heat treated at high temperature (between 1600° F. and 2000° F.) not only to remove rolling strains but also to enhance the electrical properties of the steel. As is known to those skilled in the art, such treatment poses a serious problem in supporting the hot silicon steel. The conveyor elements and the steel are at high temperature and it has been found that conveyor elements such as supporting rolls of usual composition tend to collect accretions of material from the steel which dent the steel passing over or around the conveyor elements. In the heat treatment of silicon steel at high temperature the higher the silicon content of the steel the more acute is the problem. However, the phenomenon of accretion formation is complex and is also influenced by the tension of the strip passing around the rolls when the steel is in strip form, the composition and temperature of the atmosphere and the character of the roll surface. It has already been proposed to use refractory inserts such as inserts of silicon carbide in furnace conveyor elements, the refractory inserts supporting the work passing through the furnace. While no oxide coating forms on silicon carbide inserts and such conveyor elements are satisfactory for annealing sheets, it has been found that in continuous strip heat treating furnace in which silicon steel strip is being heat treated at high temperature where the strip wraps around the rolls under tension some accretions form even on silicon carbide inserts. Furthermore, the provision and application of the refractory inserts entails substantial labour and expense. It has heretofore been proposed to provide a process of bright annealing metallic products, such as stainless steel strip and other nickel-chromium alloys, nickel-chromium-iron alloys, and other chromium and/or nickel containing alloys, in which the work during its travel through the treatment apparatus is supported by, and has its under surface in contact with, a hearth of non-metallic material preferably graphite.

In the practice of our improvement we desirably employ an improved conveyor element which has materially increased strength for the quantity of costly high temperature alloy used in its manufacture.

We have discovered that if the work-contacting portions of the conveyor elements are carbonaceous they provide a suitable support, have a satisfactory life and do not pick up accretions. We find that the heat treatment at high temperature of silicon steel which is supported by carbon during the heat treatment can be effectively and efficiently carried out while the carbon supporting the steel has long life and is structurally strong.

For example, when silicon steel is to be decarburized it is preferably in sheet form

[*Price* 2/8]Price 4s 6d

Price 3s 6d

and is desirably strip steel. It is preferably continuously moved through a chamber under decarburizing conditions, the chamber desirably containing a hydrogeneous atmosphere, and is at a temperature between 1600° F. and 2000° F. during at least a portion of its movement through the chamber. We support the strip by carbon during its movement through the chamber. We desirably continuously draw the silicon steel strip about rotatable rolls through the decarburizing chamber and provide the rolls with carbonaceous work supporting portions which engage and support the silicon steel strip during its movement through the chamber. The rolls may be carbon-faced rolls cooperating with the strip so that only carbon touches the strip in the decarburizing chamber. The rolls may be faced with either graphite or amorphous carbon, each of which has advantages. Graphite is stronger than amorphous carbon in compression and shear, is more easily machined and is more resistant to oxidation. Amorphous carbon is more resistant to wear and lower in cost.

In the accompanying drawings we have illustrated a present preferred method of practicing the invention and have shown present preferred apparatus for use in practicing the invention in which:

Figure 1 is a diagrammatic view of a decarburizing chamber showing how strip is supported for passage therethrough;

Figure 2 is a view partly in elevation and partly in axial cross section of one of the rolls employed for supporting the strip in the decarburizing chamber; and

Figure 3 is an end view of the roll shown in Figure 2.

Referring now more particularly to the drawings, and first to Figure 1, there is shown a furnace chamber designated generally by reference numeral 20 through which silicon steel strip 21 is adapted to be drawn, the strip passing over a series of rolls at the top of the furnace and beneath a series of rolls at the bottom of the furnace, all of the rolls desirably being of uniform construction and each being designated by reference numeral 22. The rolls 22 may be driven or may turn idly as the strip is drawn through the chamber. The chamber is heated internally by suitable heating means such as electric heating elements (not shown). It is heated to a temperature between 1600° F. and 2000° F. The decarburizing chamber is maintained under decarburizing conditions and for purposes of illustration will be deemed to contain a hydrogeneous atmosphere. The exact composition of the atmosphere is not of moment; in a hydrogenous atmosphere the chief active agent is hydrogen. The hydrogen is normally diluted with nitrogen and the atmosphere may also contain other ingredients such as water vapor and carbon monoxide. The hydrogen of the atmosphere combines with carbon of the silicon steel forming methane. Instead of a hydrogenous atmosphere other suitable atmospheres may be used; for example, an atmosphere containing a quantity of carbon monoxide. The decarburizing process *per se* is known.

The rolls 22 may assume various forms, one form being shown in Figures 2 and 3. Referring to those figures, each of the rolls 22 may comprise a metal body designated generally by reference numeral 2 and a carbon sleeve 3. The sleeve 3 may, as above indicated, be of either graphite or amorphous carbon. The roll body 2 comprises a barrel 4, two shaft ends 5, two drive rings 6 and two closure plates 7, the shaft ends 5 being filled with heat insulating material 8. The barrel 4, the shaft ends 5, the drive rings 6 and the closure plates 7 may be of any suitable ferrous or non-ferrous high temperature alloy such as is used in the manufacture of furnace conveyor elements.

The barrel 4 has axially spaced circumferential projections or lands 9 forming bearings for the sleeve 3 and a vent 10 establishing communication between the outside and the inside of the barrel 4 to permit venting of heated air from within the barrel when the roll is brought up to temperature and entrance into the barrel of air from the outside when the barrel cools and the heated air within contracts. The shaft ends 5 have cylindrical portions 11 fitting within the ends of the barrel 4, tapered portions 12 and cylindrical end portions 13 and 14 of relatively great and relatively small diameter.

The roll may be mounted for rotation in conventional manner.

The ends of the barrel 4 are welded to the shaft ends 5 by welds 15. The closure plates 7 are welded to the shaft ends 5 by welds 16. The drive rings 6 are welded to the barrel 4 by welds 17, but one of the drive rings is not applied and welded to the barrel until after the sleeve 3 has been put in place on the barrel. Each of the drive rings 6 has a series of circumferentially spaced radially and axially extending projections 18 each of which enters a slot 19 provided therefor in one of the ends of the sleeve 3 thus locking the sleeve to the roll body so that the roll functions as a unit.

The sleeve 3 constitutes the work-engaging portion of the roll and its outer cylindrical surface is the work-engaging surface of the roll. If the sleeve is made of graphite finely divided particles of graphite may be bonded with a suitable binder, such, for example, as bituminous material such as tar, compressed into hollow cylindrical shape as shown and baked. The slots 19

may be molded into the sleeve at the time of its formation or may be cut out afterward. A sleeve of amorphous carbon may be made by baking in a kiln a mixture of anthracite coal petroleum coke and pitch. An amorphous carbon sleeve may be changed into graphite by being further heated in a graphitizing furnace to effect transition of the carbon to graphitic form.

When the parts are cold the outside diameter of the circumferential projections 9 is slightly less than the inside diameter of the sleeve 3 so that the sleeve may easily be applied over the barrel. However, when the roll is brought up to temperature expansion of the barrel results in a tight fit between the barrel and the sleeve so that the sleeve tightly embraces the roll body.

The carbonaceous work-engaging surface of the roll is superior to silicon carbide and also superior to the oxide surfaces in inhibiting accretion formation. Moreover, even with high strip tension the strip-engaging surfaces of the rolls 22 are maintained smooth by use, perhaps even somewhat improved and polished, which is just the reverse of the behaviour of other rolls.

While we have shown and described a present preferred method of practicing the invention it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously practised within the scope of the following claims.

What we claim is:—

1. A method of heat treating silicon steel in which silicon steel is heated to a temperature between 1600° F. and 2000° F., which comprises supporting the silicon steel by carbon during the heat treatment to inhibit formation of accretions on the supporting means.

2. A method according to claim 1 for the decarburizing of silicon sheet steel in which silicon sheet steel is moved through a chamber containing a hydrogenous atmosphere and is at a temperature between 1600° F. and 2000° F., during at least a portion of said movement, and in which the silicon sheet steel is supported by carbon during such movement.

3. A method according to claim 1 for the heat treatment of silicon steel strip in which silicon steel strip is continuously moved through a chamber containing a non-oxidizing atmosphere and is at a temperature between 1600° F. and 2000° F., during at least a portion of said movement, and in which the silicon steel strip is supported by carbon during such movement.

4. A method according to claim 3, which comprises drawing the silicon steel strip through the chamber about carbon-faced rolls so that only carbon touches the silicon steel strip in the chamber.

5. A method according to any one of the preceding claims, which comprises supporting the silicon steel by graphite or amorphous carbon.

6. The method of heat treating silicon steel supported by carbon substantially as hereinbefore described.

7. Silicon steel whenever heat treated by a method according to any one of the preceding claims.

For:

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714,525 COMPLETE SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

Fig. 1.

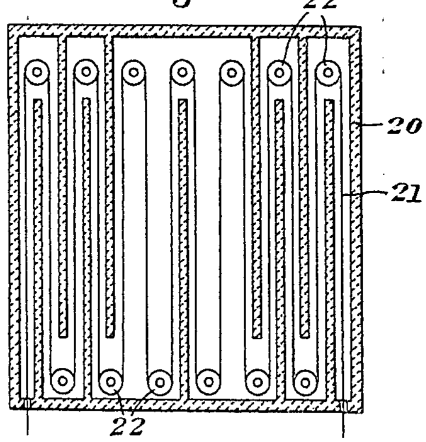

Fig. 2.

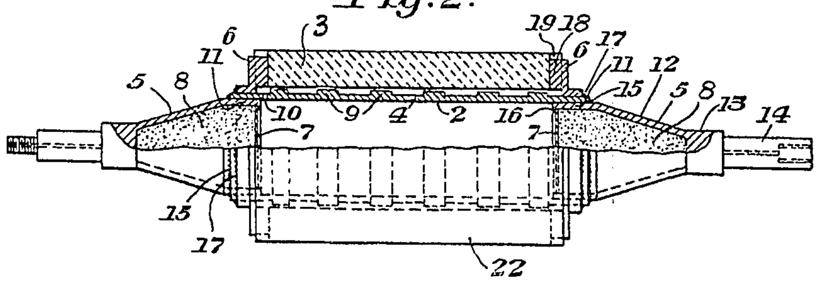

Fig. 3.